Original Article

Wits Appraisal Study: 100 Cephalometric Analyses of Chinese Teenagers

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Abstract

A cross sectional study was carried out within the lateral cephalograms on 100 Chinese teenage patients at the department of orthodontia in the second affiliated hospital of Dalian Medical University, CHINA in order to evaluate the Wits measurement as compared to ANB angle for identifying the anteroposterior skeletal discrepancy between maxilla & mandible and to determine the normal Wits value suitable for Caucasian descent whether it was applicable or not on the Chinese teenagers distributed according to sex, age & malocclusion variations. Non probability (purposive) sampling technique to collect 100 samples of lateral cephalometric radiographs and data were collected from the measurements of multiple planes & angles formed by adjoining various anatomic landmarks connecting to each other in those radiographs. Lateral cephalograms of those 100 subjects were divided according to gender, age & malocclusion type. In the sex group there were 43 males & 57 females. In the age group 68 patients' ages were from 13 to 15 years and 32 patients' ages were from 16 to 19 years. In the malocclusion group 41 patients had class I, 40 patients had class II & 19 patients had class III malocclusions. Statistical analyses were done by t-test (two independent samples) to detect the differences between two sex groups and also between the two age groups. One way ANOVA (analysis of variance) was applied to evaluate the differences of malocclusion classification. The results were statistically significant when $p<0.05$. Few results were also significant when compared to the level of $p<0.01$. Sex group showed statistically significant differences of some values like UFH, LFH, TFH & SN. Age group showed statistically significant values in case of LFH & L/TFHP. Malocclusion group showed significant value only for SNA. The research revealed that international Wits value of -1.0 mm for males could be applicable to the males of Chinese teenagers as their average Wits measurements were also found the same in this study. But the international standardized Wits value of 0.0 mm for females couldn't be applicable for Chinese teenage females as their mean value of Wits measurements was found to be -1.2 mm in this study probably due to the slight maxillary retrognathism of Chinese female descents. On the other hand the difference between the Wits appraisal of Chinese male & female teenagers was found to be -0.2 mm which couldn't be considered as a major difference between them. So the normal existence of the Caucasian Wits value of a one mm discrepancy should be modified to -0.2 mm if we want to apply this on teenage patients of Chinese population.

Key words: *Chinese teenagers, Wits appraisal.*

Introduction

Radiographic cephalometry has become one of the most important tools of both clinical & research based orthodontics. Cephalometric radiographs enable clinicians to qualify facial & dental relationships and thereby assess more accurately the extent to which a patient deviates from normal facial & dental morphologies. By comparing anatomic relationships in an individual patient to the relationships found in a group of persons with normal occlusion, the normality of a patient can be determined.

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Standardized cephalometric x-rays are preferred by orthodontists as an aid in diagnosis to evaluate the pretreatment dental & facial relationships of a patient to evaluate changes during treatment and to assess tooth movement & facial growth at the end of treatment. On the cephalometric film teeth can be related to other teeth, to the jaw in which they reside and to cranial structures. Maxilla & mandible can be related to one another and other structures in the cranium, and the soft tissue profile can be evaluated.

The Wits appraisal of jaw disharmony employs just one measurement and is intended as a diagnostic aid whereby the severity or degree of anteroposterior jaw disharmony can be measured on a lateral cephalometric head film. It is to be used as an adjunctive along with other analysis mainly to confirm their results. ANB angle is the most commonly used reading for the appraisal of horizontal disharmony of the face. The SNA reading merely shows whether the face protrudes or retrudes below the skull. ANB angle in normal

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Reliability of ANB angle is suspected in cases where the mandibular plane angle (Go-Gn to S-N) reading is considerably higher or lower than the mean of $32^{o}\pm5^{o}$.[3] Wits appraisal entails drawing perpendiculars on a lateral cephalometric head film tracing from point A & point B onto the occlusal plane (which is drawn through the region of maximum cuspal interdigitation). The points of contact on the occlusal plane from points A & B are labeled AO & BO respectively. Wits appraisal is significantly greater in the patients having anterior mandibular crowding that indicates a tendency of class II jaw dysplasia.[4] In skeletal class II jaw dysplasias point BO would be located well behind point AO (a positive reading) whereas in skeletal class III jaw disharmonies the Wits reading would be negative with point BO being in front of point AO. The more the Wits reading deviates from -1 mm in males and 0 mm in females, the greater will be the horizontal jaw disharmony. Considering all these conditions we became enthusiastic to perform this study at the second affiliated hospital of Dalian Medical University, CHINA in order to gather baseline data for the Wits appraisal and to evaluate its suitability for the analysis of skeletal disharmonies in Chinese teenage patients. Furthermore it was desirable to get an idea about the pattern of skeletal malocclusion in Chinese teenagers along with making comparison of investigations into the correlation between the Wits appraisal & the angle ANB for which a relationship has been shown. Another important goal of this research was to decide whether the existence of one mm discrepancy between the Caucasian sexes are applicable to Chinese teenagers or not.

Subjects & Methods

Two hundred twenty nine lateral cephalometric radiographs were selected combindly from the orthodontics departments of second affiliated hospital of Dalian Medical University and Dalian Medical University affiliated stomatology hospital, Dalian China. All of those patients visited these two hospitals for orthodontic treatment purpose during the period of March 2010 to February 2012. Their lateral cephalometric radiographs were taken in a standardized manner with ear-rods placed in the external auditory meati to stabilize the head. The patients were told to look ahead. The heads were adjusted so that the Frankfort planes were horizontal. As it was a cross sectional study, we selected the patients for this research work according to the following criteria like only teenagers of Chinese descents without marked craniofacial abnormality and previous orthodontic treatment. We also wanted to observe their first molars

& premolars in occlusion and it was confirmed by assessing their study models. Their radiographs were taken in the centric occlusion position. We excluded pre & post teenagers from this study along with the following criteria like patients with relapsed orthodontic complains, presence of observable craniofacial abnormality or retained deciduous etc. One hundred twenty nine films didn't satisfy the inclusive criteria and were consequently rejected. Non probability (purposive) sampling method helped us to select 100 patients to study their pretreatment radiographs for this research. We divided these selected 100 patients into sex, age and malocclusion groups. On gender basis we got 43 male & 57 female patients. On age basis we got 68 patients aged 13 to 15 years & 32 patients aged 16 to 19 years. On malocclusion basis we got 41 patients having class I, 40 patients having class II and 19 patients having class III malocclusion. All of their lateral cephalometries were traced by the same investigator using a sharp 3H pencil on acetate tracing paper. Tracings were performed in a darkened room with extraneous light from the viewing box blocked out. Subsequently every tracing was checked out by a second investigator. Twenty two percent of the cephalometric radiographs were selected to be retraced and rechecked to establish the degree of reproducibility of the two investigators. Following points & planes were marked on lateral tracings such as Sella (S), Nasion (N), Pogonion (Po), Subspinale (A), Supramentale (B), Maxillary plane (MX), Mandibular plane (MN), Occlusal plane (O). Lines representing the long axis of the most proclined incisors in the maxilla & mandible, AO and BO lines which were defined as perpendicular lines from the occlusal plane to Subspinale & Supramentale respectively. Occlusal plane was drawn through the region of maximum cuspal interdigitation in the manner described by Jenkins.[5] UFH & LFH were measured as perpendicular lines from maxillary planes to nasion and menton respectively. Distance between the lines AO & BO on the occlusal plane giving the Wits measurement was measured to the nearest mm. Besides those TFH & the distance between S & N points were also measured. All data were collected by various linear & angular measurements from the diagnostic lateral cephalogram of each & every sample. For example SNA, SNB, MMPA, U1MX, L1MN, U1/L1 readings were discussed in this study.

Study models of the patients were used to classify the occlusions as class I, class II & class III by assessing the general features of occlusion. All data were checked and edited necessarily after collection. Statistical calculations were performed with Microsoft Office Excel 2003 and the SPSS 13.0 for using through the windows computer program. Mean & SD of cephalometric parameters were used for data description.

Interpretation of data

Sex distribution table:

Table 1

The cephalometric radiographs of 100 Chinese teenagers.

		Male (n=43)		Female (n=57)		P
		mean	±SD	mean	± SD	value
	SNA	82.85	4.45	81.76	4.56	0.084 n.s
	SNB	28.58	5.30	77.57	4.17	0.288 n.s
	ANB	4.29	3.51	4.03	4.02	0.460 n.s
Angle	MMPA	30.10	27.85	26.23	7.20	0.824 n.s
in	L1MN	94.50	9.22	93.27	9.42	0.621 n.s.
degrees	U1MX	115.91	8.23	117.19	8.21	0.167 n.s
	U1/L1	124.22	12.15	121.56	19.29	0.601 n.s
	UFH	60.66	7.14	57.68	3.16	0.002 **
Distance	LFH	69.25	8.85	65.72	5.82	0.010 *
In mm	TFH	128.96	10.89	123.44	6.90	0.005 **
	WITS	-1.02	5.67	-1.24	4.93	0.826 n.s
	SN	69.38	4.88	67.37	4.31	0.027 *
Proportion as %	L/TFHP	53.42	3.25	53.25	2.79	0.631 n.s

n.s.=not significant *0.05>P>0.01 **0.01>P>0.001

In table 1 there is no significant difference at the p>0.05 level between males & females at all of the angular measurements. But most of the linear measurements have significant differences according to gender. Males were found having longer lower facial height and the SN plane than that of females as p<0.05. Other than these two values males were also found to have longer upper and total facial heights as p<0.01. There is no significant difference between the Wits appraisal values of two types of sexes as P>0.05.

Age distribution table

Table 2

The cephalometric values for 13-15 and 16-19 years of Chinese teenagers

		13-15 yrs (n=68)		16-19 yrs (n=32)		P
		Mean	± SD	mean	± SD	Value
	SNA	81.90	4.07	82.92	5.36	0.196 n.s
	SNB	78.26	4.11	77.47	5.78	0.539 n.s
	ANB	3.83	3.95	4.83	3.41	0.137 n.s
Angle	MMPA	27.87	22.62	27.94	7.10	0.151 n.s
In	L1MN	94.15	10.13	93.05	7.32	0.379 n.s
degrees	U1MX	117.22	8.22	115.41	8.17	0.177 n.s
	U1/L1	122.41	18.33	123.33	12.29	0.868 n.s
	UFH	59.09	5.78	58.70	4.67	0.534 n.s
	LFH	66.15	7.39	69.55	7.17	0.024 *
Distance	TFH	124.67	8.49	128.25	10.30	0.094 n.s
In mm	WITS	-1.59	4.99	-0.20	5.70	0.167 n.s
	SN	68.10	4.84	68.51	4.29	0.877 n.s
Proportion as %	L/TFHP	53.57	3.32	52.80	2.02	0.028 *

n.s.=not significant *0.05>P>0.01

In table 2 we see no significant difference between the two age groups at the level of p>0.05 at all of the angular measurements. But significant differences were found between the two age groups at two linear measurements. Lower facial height is statistically significant at the level of p<0.05 and we see that mean value of lower facial height is more in the older group aged (16-19) years. In case of face height proportions the p value is significant between these two age groups at the level of p<0.05 and we see both the mean value and standard deviations are higher in younger aged group of (13-15) years.

Malocclusion distribution table

Table 3

The cephalometric values for Chinese teenagers

		Class of malocclusion						
		I (n=41)		II (n=40)		III (n=19)		P
		mean	±SD	mean	±SD	mean	±SD	value
	SNA	82.92	5.67	82.55	3.16	80.05	3.64	0.028 *
	SNB	77.82	5.72	78.54	4.06	77.29	3.35	0.599 n.s
Angle	ANB	4.91	4.04	4.01	3.63	2.76	3.30	0.132 n.s
in	MMPA	26.61	5.80	29.42	29.20	27.45	7.74	0.688 n.s
degrees	L1MN	92.97	9.63	96.10	8.54	90.74	9.44	0.136 n.s
	U1MN	115.47	8.20	117.70	7.56	116.92	9.55	0.433 n.s
	U1/L1	124.72	12.07	122.31	12.89	119.18	28.37	0.514 n.s
	UFH	59.69	7.36	58.45	3.80	58.47	2.85	0.862 n.s
Distance	LFH	68.29	7.82	66.75	8.04	66.00	4.95	0.145 n.s
in mm	TFH	126.89	9.04	125.35	10.76	124.47	5.39	0.343 n.s
	WITS	-1.77	5.45	0.26	5.02	-2.76	4.70	0.055 n.s
	SN	67.28	4.11	69.36	5.43	67.92	3.54	0.329 n.s
Proportion as %	L/TFHP	53.06	3.34	53.46	2.64	53.61	2.96	0.880 n.s

n.s =not significant *0.05>P>0.01

Classification of the malocclusions based upon the study models revealed that 41 patients (41 percent) had class I, 40 patients (40 percent) had class II and 19 patients (19 percent) had class III types of malocclusion. In table 3 no significant difference was noticed at the linear measurements. In the angular measurements only SNA was found significantly different at the level of p<0.05. Judgment by the mean values SNA was found highest in class I type occlusion, average in class II type occlusion and least in class III type occlusion. But the values according to standard deviation SNA was found highest in class I, average in class III and least in class II malocclusion.

The Wits measurements given in table 1, 2 & 3 showed no statistically significant differences when distributed according to gender, age and malocclusion type. The norms for the males & females of combined age group of (13-19) were -1.0 and -1.2 millimeters respectively. Whereas they were -1.6 millimeters and -0.20 millimeters for the patients of combined sexes aged 13-15 & 16-19 years respectively showed in table 2. The Wits measurements for the different malocclusions are displayed in table 3 where we see no significant difference between all three types of malocclusion as $p>0.05$ here and the norm for class I was -1.8, for class II was 0.3 and for class III was 2.8 according to mean values.

Analyses using the conventional intracranial reference planes in lateral cephalometric radiographs taken in the natural head posture[6] indicate comparable ANB values between Chinese and Caucasian males which were in agreement with several previous studies[7]. Similarly the ANB value of 4.3° for males and 4.0° for females in the present group of Chinese teenage patients were found to be comparable with the Caucasian standards of between 2.5 degrees and 4.5 degrees. However, the true horizontal was the reference line for AB assessment of the sagittal skeletal pattern, it clearly showed that Chinese males were skeletally class III as compared with Caucasians[8]

Results

The findings from this investigation of Chinese teenage patients suggest that the most appropriate values for males should be -1.0 millimeter and -1.2 millimeters for females. It supports the ideal Wits value of -1.0 millimeter for males reported by Jacobson[9]. But it doesn't support the existence of Wits value of 0.0 millimeter ideal for the Caucasian females compared to these current teenagers. Such a correction is probably due to the mild maxillary retrognathism which is shown by the female teenage patients of Chinese descent.

It also doesn't support the existence of a one millimeter discrepancy between the sexes as reported by Jacobson. Because in this study the difference between the Wits measurements of males and females was only -0.2 millimeter which was not a major difference between the genders.

Data analyses were performed under different categories with respect to sex (male & female), malocclusion type (class I, class II & class III) and age groups (13-15 and 16-19 years). It was found that both the angular & linear measurements were comparable to the existing norms established for the Chinese population. The Wits appraisal value will have to be modified in order to be applicable only to the females of this population with -1.2 millimeters.

Discussion

In several published studies the occlusal plane was defined as the plane of maximal cuspal interdigitation[10] which originated the Wits appraisal. The same plane has also been referred to as the 'functional' occlusal plane because it was considered to be the functional plane of the masticatory area. The plane of maximal cuspal interdigitation was noted to be concave in many subjects. This observation led Jacobson [11] to recommend that "the most suitable and convenient method of standardizing the plane of occlusion is to join the midpoints of overlap of the mesiobuccal cusps of the first molars and the buccal cusps of the first premolars".

Although subsequent studies on Caucasian population has confirmed Jacobson's findings, comparisons between the results must be considered with caution as some of the authors failed to specify which method of drawing the occlusal plane they used [12]. Some even defined their own [13]. It is noteworthy that Jacobson's original method has without justification been ignored when the Wits appraisal has been calculated in subsequent studies. However in this study of Chinese teenagers the same definition & terminology of the occlusal plane were deliberately adopted so as to avoid confusion and ensure comparability with Jacobson's work.

Based upon data for the Wits appraisal based upon subjects with "excellent occlusions" Jacobson proposed the norm to be -1.0 millimeter for males and 0.0 millimeter for females. He stated that the Wits reading should be positive for the class II dysplasias and negative for class III dysplasias. Thus increased deviations from the norms would indicate more severe anteroposterior jaw disharmonies.

Maxillary protrusion, maxillary jaw base length, face height, ramus height, squarish craniofacial outlines[14], denture widths[15] and shorter sella nasion length[16] have been shown to be associated with prognathism in Chinese subjects.

The only comprehensive lateral cephalometric analysis of Chinese teenagers was based on films taken in natural head posture. To facilitate comparability with other clinical studies and to show the relevance of the results with patients under treatment, analysis of radiographs taken in a standardized position is more useful. In addition the present sample was not selected according to malocclusion or profile.

Although it would be advantageous to directly compare investigations into the correlation between Wits appraisal and the angle ANB for which a relationship has been shown, it is at a relatively low level with a range of 0.60 to 0.67 [17]. The authors agreed that the inter-individual variables affecting the angle ANB and the Wits measurement would make a perfect correlation unlikely and that the analysis is mathmetically complex[18]. As there is probably little clinical application of such a technique, the correlation between these two assessment techniques was not investigated in the present study.

Abbreviations used:

SNA: Sella, Nasion, Point A.
SNB: Sella, Nasion, Point B
ANB: Point A, Nasion, Point B
MMPA: Maxillary-Mandibular Plane Angle
U1MX: Upper incisor angle to the Maxillary plane
L1MN: Lower incisor angle to the Mandibular plane
U1/L1: Inter incisal angle
UFH: Upper Facial Height
LFH: Lower Facial Height
TFH: Total Facial Height
L/TFHP: Proportion of Lower facial height to the Total facial height
FH: Frankfort Horizontal
AB: Point A, Point B
SN: Sella Turcica, Nasion
APDI: Antero-Posterior Distance of Incisors
SD: Standard Deviation
SPSS: Statistical Package for Social Science

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